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Sustainable Transitions on the Move – Guiding Visions for a Circular Bioeconomy in Scandinavia

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Introduction

Grand societal challenges such as climate change, ageing population and food security feature increasingly on the agenda of policymakers at all scales. While traditional mission-oriented research and innovation policies were largely framed in technical terms, challenge-based policies claim to be less instrumental and more open-ended. One cannot simply specify the problem and develop a diagnosis but one needs to learn about the nature of the grand challenge in order to address it. This implies greater deliberation and contestation, both with respect to policy aims and means, and involves new actor constellations that include a larger variety of actors, and consider new roles for traditional actors (Kuhlmann and Rip 2014). Even if policies start to be aimed at addressing these challenges, this new framing of research and innovation policies is still under-developed and it remains unclear how to implement such policies (Coenen et al. 2015; Schot and Steinmuller 2016).

Challenge-driven research and innovation policy is distinct from previous paradigms in its explicit acknowledgement of directionality of change and innovation which requires the setting of collective priorities (Steward 2012). Drawing on insights from sustainable transitions theory, shared future visions are considered essential for providing such directionality (Weber and Rohracher 2012) and a prominent aspect in governance approaches to challenge-driven research and innovation (Loorbach 2010; Raven et al. 2010).

Developing shared future visions requires however some form of boundary objects around which heterogeneous sets of actor groups negotiate collective pathways of change and innovation by articulating their world-views and interests. Here, a boundary object is understood as an entity interpreted in different ways within different communities, while at the same time, holding sufficient corresponding content to allow communication between

these communities (Star 1989). The notion of a *circular bioeconomy* may be seen as a prime example of such a boundary object: it constitutes a key discourse in challenge driven research and innovation policy, as in, e.g. Horizon 2020, yet it open still for very different interpretations (Bugge et al. 2016).

The aim of this paper is to contribute to knowledge on the nature of challenge-driven research and innovation policy by looking into the boundary object of the notion of a circular bioeconomy. The paper is unpacking processes of deliberation and contestation among sets of heterogeneous actors that underpin the guiding visions for a circular bioeconomy.

We apply recent developments in social movement theory and new industry emergence (Schneiberg and Lounsbury 2008; Hargrave and Van de Ven 2006; Pacheco et al. 2014) as a conceptual approach. According to this literature, social movements bring about change by contesting the practices of the incumbents and driving the institutionalisation of emerging industries. The social movements are developing through political processes in which actors ally themselves with activists and groups with complementary interests. In isolation, they do not have the resource or power to produce change, and so they engage in a “grassroots” form of organisational networks to create change (Van de Ven et al. 2007; Smith et al. 2012).

From here, we build on the findings from a study of visions for a circular bioeconomy in Scandinavia (Reime et al. 2016). The study gives an overview of the visions by focusing on the nature of the circular bioeconomy, who drives it, and how it has driven thus far. Our findings highlight differences between the Scandinavian countries: in how the guiding visions emerge and co-evolve over time; in the various actor interests; in their networking and in their shared interests.

Social Movements and Sustainable Transitions

The theoretical framework on social movements relates to a broader theoretical framework of institutional analysis of organisational change, innovation and industrial dynamics. More recently, this socio-political dimension has been called to attention in the literature on sustainable transition. This section provides an overview of these literatures, of how these relate, and how these may contribute to gain further insights on the nature of grand societal challenges and the challenge-driven research and innovation policy. In particular, we apply these literatures to study the social movements underlying shared guiding visions.

Social Movements on Industry Emergence

The literature on social movements adds to literature on industry emergence a greater understanding of the role and dynamics of political change processes in the creation of new industries. It requires us to focus on ways in which industrial actors ally themselves with activists and groups with complementary interests to pursue their interests. Their enactments are contesting the practice of existing constellations and driving the institutionalisation of an emerging industry. In isolation, they do not have the resource or power to produce change, and so they engage in a “grassroot” form of organisational networks to create change (Schneiberg and Lounsbury 2008; Hargrave and Van de Ven 2006; Pacheco et al. 2014).

The knowledge builds on two fields of literature, the literature on technology innovation management and the social movements on institutional processes. In the literature on technology innovation management, the emergence of a new industry within an existing social system are regarded to have many parallels to social movements (e.g. Lounsbury and Ventresca 2002; Garud et al. 2002). This literature focuses on how a technical innovation is co-evolving in the activities of the entrepreneurs and the institutional dynamic of the supporting infrastructure (Garud and Van de Ven 1987; Garud et al. 2002). In the literature on social movements, the collective mobilisation processes often extend from social and environmental problems, where the need for action to prevent or hinder social change mobilises actors. This literature focuses on how, over time, a social movement results from the ongoing activities of many dedicated people (Rao et al. 2000; Schneiberg and Lounsbury 2008). The theorising on industry emergence in sustainable industries, e.g., clean energy, may benefit from the literature on social movement (Hiatt et al. 2009; Pasheco et al. 2014).

In both literatures, some individuals or groups see a need for change and link this need to existing problems or opportunities (Hargrave and Van de Ven 2006; Smith et al. 2012; Pasheco et al. 2014). These changes become institutional changes in the social system. Yet, in order to understand the dynamic interaction between the raised problems or opportunities in the institutional context of the social system, both fields of literature call attention to the need for studying ongoing processes of change at multiple levels. Both also emphasise the role of political processes, conflicts and power, in the making of the new understanding. The action and interaction is seldom smooth and linear in style, but co-evolve in many parallel processes over time. Some action may even contradict movements of other actors. Most often, it results out of both converging and diverging interests and activities, in a complex process of interaction in a broader setting of the social system.

Coevolution and Collective Interests

Studies of coevolution have described the complex processes of interdependence among organisations, institutions and technical development in organisational fields (Van de Ven and Garud 1994; Garud et al. 2002; Geels and Schot 2007). Coevolution is a process in which one element simultaneously impacts the path of others in the system. Organisations co-evolve with each other and the institutions that govern action in the organisational fields in which they embed.

In the seminal contribution of the study of the cochlear implants program by Van de Ven and Garud (1994), attention called to how the technological advance of the implants at the micro-level of the firm was coevolving in a broader technical and societal context over time. They emphasised how the new technology emerged in coevolution with broader social systems of technical activities, resource endowments and institutional arrangements. Geels and Schot (2007) provide a further example of the critical importance of social and institutional events on technical development, in discussing the evolution from cesspools to sewer systems in 19th century Holland. Steam pumps and waste processing technology developed in the 1870s and 1880s, but did not come to scale until hygiene and cleanliness became dominant institutionalised cultural values in the 1890s and 1900s.

Van de Ven and colleagues have later emphasised the inter-organisational character and collective interest in innovation processes (e.g., Van de Ven and Hargrave 2004; Hargrave and Van de Ven 2006; Van de Ven et al. 2007). Innovation is driven by the desire of people to develop and implement new ideas, but it is not the endeavour of the unique single entrepreneur. Innovation is the result of the interaction over time of many dedicated people, developed in converging and diverging activities. Hence, their various ideas, reinvention and terminations are co-evolving in overlapping, but also in conflicting interests, in the inter-organisational processes in the broader setting of the social system.

These works are about the increased likelihood for succeeding when other people are sharing related interests (Garud et al. 2002; Hargrave and Van de Ven 2004; Van de Ven, et. al 2007). It is simply easier to recognise interests when action is frequently supported by other actors, in the action of partisan actors. They start to share ideas through recognised overlap of interests. When they recognise their common beliefs, it is easier to mobilise financial support and personnel resources needed. These collective opportunities emerge from the overlap of interests of many individuals. These entrepreneurs are recognising the need for making allies with other actors and corresponding interests, and building powerful coalitions between

related interests. However, rival constellations appear along similar lines, and existing structures are hard to unravel. Yet, these conflicts among various constellations also drive the process of change. Through their political behaviour, they facilitate and constrain their own interests.

Shared Interests in Guiding Visions

Parties who continually interact come to share ideas about how things should be done (Weick 1995). They start interacting on their corresponding issues. Hence, their common interests make a ground for making allies. Over time, this interaction often result in a co-evolution of shared values of their corresponding individual interest. They identify joint opportunities for reaching a mutual goal of their interest. Through recognising shared values, the collective action is constructing the opportunities for reaching common interests in social processes. With this development, norms and interests become dissociated from the specific situations in which they emerged and generalised to cover broad areas of collective activity. These values develop from their collective achievement created in the interaction over time, in their converging and diverging activities (Garud et al. 2002; Van de Ven et al. 2007).

This knowledge on social movements, coevolution and collective interests may contribute to extend the insight on the nature of the challenge driven innovation research and policy by focusing on the guiding vision as a tool. As pointed at in the introduction, shared visions are considered essential for providing the needed directionality in governance approaches to challenge-driven research and innovation (Loorbach 2010; Raven et al. 2010). Often such shared future visions manifest as plausible future scenarios, by formulating the technical, institutional and behavioural problems that are to be solved. Such shared verbalisations of the problems are providing a stable point of reference for target setting and monitoring, or at least stipulating a metaphor that can unite different actor groups and focus capital and resources (Smith et al. 2005).

There is, however, a risk that a theoretical framework building on the ideas of coevolution simply becomes a shorthand for everything connects to everything else, providing us with little analytical purchase (Schamp, 2010). To unpack processes of deliberation and contestation it is therefore critical to maintain clear and distinct analytical categories. To do so we distinguish between the following dimensions of how guiding visions emerge and co-evolve over time: i.e. actor interests, forging of partnerships in networks and shared interest in collective action.

Furthermore, recent literature has identified three enduring challenges for grassroots movements when creating visions for institutionalised change (Smith et al. 2012). These are: 1) addressing local concerns while at the same time affecting larger scale change; 2) having appropriate actions for the current situation yet at the same time seeking to change the current situation; and 3) focusing on project-based actions, yet seeking structural change (Smith et al. 2012). Our empirical mapping of the notion of a circular bioeconomy in Scandinavia may contribute to further understanding of the nature of these enduring challenges and how these may overcome in emerging and co-evolving interests of the actors, in their networking, and in their shared visions over time.

Methodology

The methodological approach is based on a recursive literature search and adapting the empirical grounded mapping methods developed by Strauss and Corbin (1998). An empirical grounded mapping structures the analysis into categories generated within the study, by using practical techniques for collecting and interpreting data (Strauss and Corbin 1998; Corbin and Strauss 2015). Collecting and analysing data are thus parallel processes, where preliminary results give rise to new rounds of collecting data, analysis and findings. The method is a strength in situational analysis, to examine possibilities and threats of the strategies and the capabilities of the central actors, as in this case of the circular bioeconomy.

The findings build on an empirical grounded mapping of a circular bioeconomy in Scandinavia. In the empirical mapping, data was collected and analysed on the existing visions in the three Scandinavian countries: Norway, Sweden and Denmark, through three steps. The data was collected between January and March 2016.

First, we conducted a web-based search for the three national categories of a *circular bioeconomy*. These searches resulted in little results for any of the three countries.

Second, we used *bioeconomy* as a broader search term¹. This part of the mapping focused on visions with *explicit and actual use* of the term *bioeconomy*. In contrast to the dearth of findings on the search for a *circular bioeconomy*, this mapping returned a large number of findings in all three countries. This demonstrates that while the term *circular bioeconomy* is still new in the Scandinavian countries, the term *bioeconomy* seems to be broadly applied.

¹ NO: Bioøkonomi, DK: Bioøkonomi, SE: Bioekonomi

Naturally, not all documents were relevant for our analysis of the notion of a circular bioeconomy in Scandinavia. Many findings simply addressed a need for a bioeconomy and focused little on the possibility in the circularity of this economy. This also showed that the dimension of circularity is not established, in relation to the term of bioeconomy. Another central dimension was to consider the visions for *value chains of organic waste and by-products*, as the specific analytical context for the research project SusValueWaste², as this study was a part of. These findings helped to structure the identification of the notion of a circular bioeconomy from the general findings on the bioeconomy.

Third, we collected more information on the content of the mapped visions. This was done by the showball method, following the findings in the second phase, and going into depth in search for information on the various visions and the actors that hold these visions. These included a further collecting of data on the various strategies held by the various actor interests for a circular bioeconomy. As identified in the second step, these various actors were: national governments, regional governments, public agencies, research councils, research and education, industrial federations, companies, civil society organisations, etc. In this part of the analysis, statements that could translate or interpret as referring to a circular bioeconomy were considering as data for the analysis. This step of the data collection and analysis resulted in detailed data, e.g. the state of the vision, the various actors involved, their various activities to influence on the vision, their related strategic documents, etc.

Certainly, this methodological strategy has its limitations. The most obvious is the data ignored when applying the search term of a *circular bioeconomy* as the entry to the empirical phenomenon. By applying this term, it may implicate that we have missed the guiding visions that apply a different terminology. At the other hand, the data collection was made on the assumption that the most central visions would address the notion of a bioeconomy, as the broader term we applied in the second step. More importantly, the mapping of the visions did not aim at creating an overview of all possible related strategies indirectly aimed at the topic. Rather contrary, in choosing the still unfinished notion of the circular bioeconomy, the study aimed at capturing the visions in flight, in the making of an emerging industry for a circular bioeconomy. We regarded the notion of a circular bioeconomy a prime example of a boundary object, which hold sufficient corresponding content to allow communication between different communities (Star 1989). The notion establishes a common ground for

² For information on the SusValueWaste project, see: <http://www.susvaluewaste.no/>

studying emerging and co-evolving processes of actor interests, their partnership in networks, and their shared interests in collective actions, in the setting of a new and sustainable industry emergence. Studying an industry in emergence may give us glimpses into the underlying patterns of change, in the evolving processes and ongoing debates of the partisan actors, as pointed at in the theoretical literature on social movements on industry emergence.

Findings: Guiding Visions for a Circular Bioeconomy in Scandinavia

This section gives an overview of the findings of the guiding visions for a circular bioeconomy in Scandinavia, by presenting the empirical mapping of who drives it and how it has been driven so far.

Denmark

Denmark does not have a dedicated bioeconomy strategy. The development of the Danish bioeconomy is addressed in several sectorial strategic documents that are part of the bioeconomy³. In this way, the concrete focus areas and proposed initiatives are directly addressing the different sectors belonging to the bioeconomy. Some of the more traditional bioeconomy sectors in Denmark, e.g. agriculture, are described as highly productive and efficient in the way they extract value from biomass.

In 2011, Denmark launched a new governmental energy strategy including the long-term goal of becoming completely independent of fossil fuels (coal, oil and gas) by 2050⁴. In this strategy, the primary focus for biomass was in relation to its potential to become feedstock for bioenergy production (Gregg et al. 2014). Since then, different stakeholders in Denmark have put a strong emphasis on developing a sustainable bioeconomy that can secure long-term economic growth and position the country as a leader in providing sustainable solutions in the global bioeconomy.

In 2013, the Danish Government launched a series of national growth plans grouped under the title *Denmark at work*. The growth plans describe initiatives and focus areas within different sectors of the Danish economy that can generate economic growth and jobs in the country, and can generate competitiveness for Danish enterprises in the global market.

³ The Danish Government (2013): Denmark at Work. Plan for Growth for Water, Bio & Environmental solutions.

³ The Danish Government (2013): Denmark at Work. Plan for Growth for Food Industry.

⁴ Danish Government (2011): Energy Strategy 2050.

The objective of the Plan for growth for Water, Bio and Environmental solutions is to strengthen Danish and European markets within these sectors. The strategy intends to support new business opportunities and facilitate product and technology development within enterprises. The strategy mentions the strong position that Denmark possesses within industrial biotechnology and the great potential in relation to the production of bio-based materials. It also defines a strategic focus for strengthening the potential for future market pull for bio-based solutions to generate growth and jobs. Overall, the goal is to support Danish enterprises in claiming a greater share of the growing international market within the areas in which Denmark possess strengths and competitiveness, and hence make a positive contribution to growth and job creation.

A direct result of the Plan for Growth for Water, Bio and Environmental solutions was the establishment of the National Bioeconomy Panel in 2013. The Panel consists of 27 members representing the Danish industry and industry associations, academia, NGOs and regional authorities. The Panel has a cross-ministerial secretariat chaired by the Danish AgriFish Agency (Ministry of Environment and Food of Denmark)⁵. Its mission is to identify the possibilities for concrete business and research initiatives that can transform Denmark into a *growth hub for sustainable bioeconomy*, this being their vision. The focus is on developing new bio-based value chains and increasing the efficiency and productivity of existing ones. The Panel has a strong focus on increasing the value extraction from by-products, and it has published a set of recommendations on how to enable the available by-products and waste streams as feedstock in the sustainable bioeconomy.

The plans and strategies launched by the Danish government and its advisory body, the National Bioeconomy Panel, designed growth strategies, which could contribute to increasing economic growth, employment and exports of Danish solutions. Furthermore, they seek to create new business opportunities and strengthen the competitiveness and innovativeness of the Danish enterprises, and place them as leaders in the global market for bio-based products and solutions. Additionally, there is also a range of industry-driven initiatives focusing on the development of the biorefinery sector and aiming as well at securing Danish global leading position in the field.

⁵ <http://agrifish.dk/about-us/the-danish-bioeconomy-panel/>

Norway

In Norway, the visions for a circular bioeconomy was identified at a later point of time, but has gained momentum since 2015. This development has been formed by the Norwegian Government's decision to develop a national bioeconomy-strategy. The Government sees the strategy as an important step to facilitate new and innovative industries that can strengthen green competitiveness and make the Norwegian economy less vulnerable to fluctuations in the petroleum sector.

In 2015, Innovation Norway launched the report *The Bioeconomy – an important contribution to growth and value creation in the future*. Innovation Norway is the government's agency policy instrument for innovation and development of Norwegian enterprises and industry. The report was a part of their initiative *the Dream Commitment*⁶. The agency has defined the bioeconomy as an important area of priority to strengthen value creation from Norwegian business. The report defines four biobased sectors: (1) Norwegian agriculture; (2) Norwegian seafood; (3) Forestry, and (4) Biobased ingredients – chemicals and energy. The report emphasises the regional clusters in creating innovation, and the need for regional located strategies to foster the opportunities. The Norwegian bioeconomy will take on different shapes in the different regions. The report summaries the most central recommendations in a need for improving general framework conditions and licensing regulations in order to facilitate increased exploitation of residual feedstock and new biological resources.

The main representative organisation for Norwegian employers (NHO) initiated a bioeconomy panel in 2015 to investigate how Norway can become world leading in the bioeconomy⁷. The possibilities for combining expertise from the marine and the agricultural sector was one of the starting points, and the panel referred to Norwegian companies which had succeeded in making use of by-products from agriculture; the ocean, the fisheries and the forest. The panel pinpointed how resources previously regarded as waste, now used to produce feed ingredients, food, bio-energy and products for pharmaceutical purposes. NHO organised the panel to provide input from the private sector to the development of the governmental bioeconomy strategy. The panel developed the vision in the report: *Towards the bioeconomy – NHO input for a new international and competitive business* in 2016⁸. The

⁶ <http://www.drømmeløftet.no/wp-content/uploads/2015/05/Biooekonomi-underrapport-Droemmeloeftet-21-mai-final.pdf>

⁷ <https://www.nho.no/Politikk-og-analyse/Forskning-og-innovasjon/Na-trenger-Norge-biooekonomi/>

⁸ https://www.nho.no/Politikk-og-analyse/Forskning-og-innovasjon/verdensledende-pa-biooekonomi/?utm_source=newsletter_11.mars.2016&utm_medium=email&utm_campaign=newsletter_all

report highlights a circular economy as one of the important principles to implement the bioeconomy⁹.

According to the report, Norway is already world leading in the marine sector, but still in the starting pit when it comes to developing new products. The vision is craving for the creation of a new, sustainable and high-tech industry based on the natural bio resources, and as well, a need for a stronger collaboration between *green* and *blue* sectors. In particular, it points to the unexploited potential in production of biomass and in exploring the intersections between the aquaculture, the agriculture, the forestry, and the biotechnologies. It sees future opportunities within health and pharma, wood-based construction materials and bioprocessing, as with bio-plastics and bio-energy.

In addition to the NHO report, there are two other stakeholder-initiated reports that is worth mentioning in this context: *Norway203040* and *BioVerdi*. The first report “Norway 203040 – the business opportunity”¹⁰ has been named: *The climate report of the business sector*. It was initiated by key players to elevate a business perspective into the public debate on climate- and environment matters¹¹. The report highlights the bioeconomy as one amongst five opportunity areas for Norway, with biofuels for transport and bio-based chemicals and plastics as the two key areas that are believed to be at the ripe for future development and worth to explore¹².

BioVerdi, was created in a partnership between 50 actors, representing Norwegian Universities and Research-bodies, science parks, industrial representatives from the bio-sectors and private investors¹³. The report defines four areas to have potential: health, marine, industrial biotech and agriculture. It also holds suggestions on how Norway can lift the four bio-businesses to becoming the *new oil* to Norway, with the use of a strong policy and collaboration between the stakeholders and the sectors.

In 2015, the Ministry of Trade, Industry and Fisheries launched a masterplan for marine research¹⁴. The masterplan is a follow up of the Government’s long-term plan for research and higher education¹⁵. It forecasts that public funding for research and development needs an

⁹ <https://www.nho.no/siteassets/nhos-filer-og-bilder/filer-og-dokumenter/forskning-og-innovasjon/mot-bioekonomi.pdf>

¹⁰ http://awsassets.wwf.no/downloads/norway203040_report.pdf

¹¹ The report is a collaboration between DNV-GL, Hydro, Kongsberggruppen, Posten & Bring, Ruter, SpareBank 1 Forsikring, Statkraft, Statnett, Storebrand, Umoe, WWF, Xyntéo and ZERO.

¹² http://awsassets.wwf.no/downloads/norway203040_report.pdf

¹³ <http://www.oslotech.no/bioverdi/>

¹⁴ https://www.regjeringen.no/contentassets/3db688adc270495aac99e655c5d28fe1/marin-strategi_webfil.pdf

¹⁵ Meld. St. nr. 7 (2014-2015) Langtidsplan for forskning og høyere utdanning 2015-2024

increase¹⁶. The development of the marine sector, referred to as the *Blue bioeconomy*, is critical in this masterplan. This development is both about modernising the traditional fishing industry, developing a sustainable aquaculture and developing the entirely new industries utilising new resources from the sea. The masterplan specifically addresses cross-sectoral and multi-disciplinary research as the way forward. One potential topic is the opportunities in a strengthen collaboration between the blue bioeconomy and other sectors, e.g. the petroleum industry and the nutrition industry. In a different report, carried out for the Ministry of Trade and Fisheries, it is stated that the bioeconomy is growing, with a potential better exploitation of residual resources and marine bioprospecting¹⁷. Critically, both these documents point to the large potential in the blue bioeconomy, as the ocean represents massive opportunities.

Sweden

In a similar way as Denmark, Sweden does not have any dedicated strategies or any ongoing processes aimed towards raising the circular bioeconomy at the governmental level.

However, a national research and innovation strategy for a bio-based economy was launched already in 2012. This strategy started a number of processes. It developed in dialogue industrial actors, public agencies and academia. The strategy identifies four major challenges that form the basis of the strategy, and outlines detailed strategies along each of these: I) replacement of fossil-based raw materials with bio-based raw materials, II) smarter products and smarter use of raw materials, III) change in consumption habits and attitudes, and IV) prioritisation and choice of measures. The strategy is both extensive and detailed in scope, identifying many solutions to the four challenges. Critics often disapprove such broad strategies for spreading out targets and fragmenting accountability. However, the Swedish innovation agency Vinnova has emphasised the need for transboundary activities, in their attempts to implement the research strategy.

Their work gave rise to the grand innovation programme *BioInnovation*, with the vision of transforming Sweden to a bioeconomy in 2050. This new research programme aspires at stimulating innovation of new biobased materials, products, and services. The objective is to create the best conditions for increased valorisation and competitiveness in the Swedish bio-based industry, through creating transboundary collaboration across sectors, in forestry, chemical, and textile industry. The programme is a partnership-based initiative consisting of

¹⁶ <https://www.regjeringen.no/no/aktuelt/vil-skape-globale-vinnere-av-havets-ressurser/id2437928/>

¹⁷ «Rammebetingelser for bioøkonomi i Norge» http://vista-analyse.no/site/assets/files/6962/2015-07_bioekonomi.pdf

over 60 partners representing companies, industrial actors, public agencies, universities and research institutes. The Swedish Forest Industries Federation coordinates the programme.

The national strategic innovation programme Re:source¹⁸ from 2016 also has an orientation towards a circular bioeconomy. The overall vision is: “(...) *to become the world leader in minimizing and profiting of waste*”. It is also partnership-based, consisting of 80 partners. These are actors mainly from the recycling and waste industry, being: material producers, manufacturing industry, research institutes, municipalities and regions. The Swedish Energy Agency runs the programme, and the SP Technical Research Institute of Sweden coordinates it. These two actors have played a major role in developing the programme. Their idea spins out of their strategic network called Waste Refinery¹⁹ established in 2007. In the end of 2015, the government decided to support the programme financially with allocating 20 million SEK per year in the period from 2016-2019. The funds are granted by Vinnova. Formas, the Swedish Energy Agency, and the companies in the programme.

Paper Province²⁰ is a third partnership-based cluster worth mentioning. It is a wood-based research and innovation initiative located in the region of Värmland. Their vision is to create products and energy from the forest, as an alternative to fossil materials. The cluster was established as early as in 1999 by seven companies in the pulp and paper industry and consists now of over 200 members. Hence, the cluster has a distinct accumulated expertise in the forest industry. In 2013, the cluster received a ten year's support programme from VINNVÄXT, a Vinnova programme to promote sustainable development in the growing field of a regional forest based bio-economy.

The forest industry has been central in several of these programmes, and the Forest Industries Federation has played a critical role. This industry federation launched their visions for a wood-based bioeconomy already in the beginning of 2000s. They have referred to the forest as *the green gold*, because of its potential to develop and offer workplaces and sustainable growth all over the country. The renewable material of timber has been emphasised, as a raw material to efficient utilisation of the renewable biomass into finished products, by-products and waste products. Their orientation towards a sustainable bioeconomy can be traced back to strategies launched in the beginning of 2000s. Early documents called for a sustainable production, e.g. *New visions – a story about opportunities* in 2007 and *Forest industries*

¹⁸ <http://resource-sip.se/>

¹⁹ <http://wasterefinery.se/>

²⁰ See: <http://paperprovince.com/>

sustainable goals in 2008²¹, and various related agendas have been discussed in strategies for a paper based industry, forest fibre industry, biofuel²², etc.

The federation has also accomplished a governmental position by inviting ministers to several seminars raising policy issues for a circular economy²³. An important fact is the many strong companies in the pulp and paper industry, which have been under a strong pressure for a need for change. The cornerstone of forestry has moved away from the traditional industrial boundaries of the forest industry in Sweden. BioInnovation is an area for investigating potentials in collaborations and in cross-sectoral projects, with e.g. the textile industry and the automobile industry. Biorefinery of the Future and Paper Province are others. The Federation of Swedish Farmers has also emphasised the forestry in their green growth vision, enabling profitability, growth and quality of life²⁴.

Discussion

As the empirical mapping shows, all three Scandinavian countries have had various activities that may sort under the entity of guiding visions for a circular bioeconomy. The findings show some interesting differences between the Scandinavian countries. Table 1 shows an overview of the guiding visions in the Scandinavian countries, sorted on various actor interests, their networks, and their collective actions, in three various dominant types of government-led, industry-led, and partnership-based networks identified from the empirical study.

²¹ Forest industries sustainable goals 2008

²² E.g. The Swedish Forest Industries Manifesto 2008; Unfold the future. The Forest Fibre Industry 2011; Biofuel from forest 2014

²³ E.g. "Vilken roll spelar skogsindustrin för en hållbar utveckling" 2011; "En hållbar bioekonomi krever økad tillväxt" 2011

²⁴ Towards a biobased economy 2015

Table 1: Overview of the guiding visions for a circular bioeconomy in Scandinavia

	Government	Market	Partnership-based networks
Denmark	<p><i>Energy Strategy 2050</i>, 2011, Danish Government 2011.</p> <p><i>Denmark without waste</i>, 2013, Danish Ministry of Environment and Food.</p> <p><i>Denmark at work. Plan for Growth for Water, Bio & Environmental solutions</i>, 2013, The Danish Government.</p> <p><i>Denmark at work. Plan for Growth for Food Industry</i>, 2013, The Danish Government.</p> <p><i>Growth and development in the entire Denmark</i>, 2015, Danish Government. Include analysis of opportunities to support the production and use of advanced biofuels.</p>	<p><i>Biorefining Alliance – Local solutions to Global needs</i>, 2011. Association, initiated by industry representatives.</p> <p><i>Denmark in a Global Bio-based Society – do we want to be customers or producers?</i>, 2012, Biorefining Alliance.</p> <p><i>The start of the Danish Bioeconomy 2015</i>, status report from the first Danish integrated biorefinery, Maabjerg Energy Concept.</p>	<p><i>Biocluster</i>, 2013-2015, a pilot project on business opportunities and innovation.</p> <p><i>Carlsberg Circular Community</i>, 2015, an innovation partnership to rethink design and packing materials.</p>
Norway	<p><i>Strategy for marin bioprospecting</i>, 2009, Ministry of Fisheries.</p> <p><i>Strategy for an environmental and sustainable marine sector</i>, 2009, Ministry of Fisheries and Coastal affairs.</p> <p><i>National strategy for biotechnology</i>, 2011-2022, Ministry of Education and Research.</p> <p><i>The Dream Commitment: The bioeconomy – an important contribution to growth and value creation in the future</i>, 2015, Innovation Norway.</p> <p><i>Bioeconomy strategy</i>, 2016, Ministry of Trade, Industry and Fisheries & the Ministry of Agriculture and Food.</p>	<p><i>Bioeconomy Panel</i>, 2015, NHO. Panel established to deliver input to the national bioeconomy strategy.</p> <p><i>Norway203040 – the business opportunity</i>, 2015, Report by elevate a business perspective into the debate on climate and environment matters.</p> <p><i>Towards the bioeconomy – input for a new international and competitive business</i>, 2016, NHO.</p>	<p><i>RUBIN</i>, 1992-2012. Foundation, aimed to contribute to a total exploitation of the fish and increased value creation of bio-feedstock.</p> <p><i>BioVerdi</i>, 2014. Partnership-based, initiative by Oslotech AS, including: industry, academia, knowledge hubs, investors and organisations.</p>
Sweden	<p><i>Swedish Research and Innovation Strategy for a Bio-based Economy</i>, 2012, Research Council Formas, VINNOVA, and Swedish Energy Agency.</p> <p><i>National Forestry Programme</i>, ongoing 2016, Swedish Government, Minister of Rural Affairs.</p>	<p><i>Paper Province</i>, 1999-ongoing, cluster, Värmland.</p> <p><i>New Vision – a Story about Opportunities</i>, 2007, Swedish Forest Industries Federation.</p> <p><i>Unfold the future. The Forest Fibre Industry – 2050 Roadmap to a low-carbon bio-economy</i>, 2011, Swedish Forest Industries Federation.</p> <p><i>The Forest Industry – the Driver for a Sustainable Bioeconomy</i>, 2012, Swedish Forest Industries Federation.</p> <p>How we reach a biobased economy – an input from the Federation of Swedish Farmers, 2015, The Federation of Swedish Farmers.</p>	<p><i>BioInnovation- Strategic Innovation Programme</i>, 2015. Partnership-based, coordinated by Swedish Forest Industries Federation. Financed by Research Council Formas, innovation agency VINNOVA, and Swedish Energy Agency</p> <p><i>Re:Source</i>, 2016, Strategic Innovation Programme by Swedish Energy Agency, VINNOVA and Formas, led by SP Technical Research Institute in collaboration with Chalmers Industrial Technology, IVL Swedish Environmental Research Institute, Swerea, Chalmers, Luleå University of Technology and Inno Group</p> <p>Sectoral strategies developed through dialogue with multiple stakeholders. Leading actors: the Swedish Forest Industries Federation.</p>

In Denmark, it was launched several visions for a circular bioeconomy in 2011-2013, but it is no dedicated governmental strategy. In Norway, on the other hand, little happened until 2015, when the national government decided to develop a strategy. In Sweden, there is also no governmental strategy, but there are several partnership-based research programmes, in networks of public agencies, companies and research and education institutions.

When we apply the theoretical framework on social movements and sustainable transitions, it may contribute to extend the insight on how and why the actor interest, their networking, and their social processes of shared visions over time have resulted in these seemingly differences in the guiding visions in the three Scandinavian countries.

In Denmark, visions have been oriented around business and export opportunities, especially around utilizing agricultural residues in biorefineries and biogas plants and municipal waste for generating heat and power. Biorefineries and firms, (i.e. Novozymes) that produce enzymes that convert cellulose to ethanol have a strong initiative to develop and license technological expertise for high value purposes. This has resulted in research activities geared toward developing new state of the art technologies within Danish industries. Value creation in the bioeconomy is linked not only to the resources, but also to licensing of state of the art technologies related to transforming bio resources into value added products (Gregg, et al. 2017). For example, Inbicon has pioneered enzymes to convert cellulosic material into biofeedstocks (Larsen et al. 2012)

In Norway, the bio-economy has been put on the governmental agenda by the decision to develop a national bioeconomy-strategy and in the several stakeholder initiatives seeking to shape it. One of the most prominent initiatives was the Bioeconomy panel, initiated by the main representative organisation for Norwegian employers (NHO), to provide input from the private sector to the development of the governmental strategy. The panel developed a vision, which embraces the bioeconomy as a key area where Norway has good preconditions. In particular, their vision points to the unexploited potential in production of biomass and in exploring the intersections between the aquaculture, the agriculture, the forestry, and the biotechnologies, in a stronger collaboration between *green* and *blue* sectors. The related stakeholder-initiated reports Norway203040 and BioVerdi have also contributed to calling at the potential, and in its central contribution to make the Norwegian economy less vulnerable to fluctuations in the petroleum sector. It seems important to several stakeholders to describe the bioeconomy as a realistic industrial *alternative* to the petroleum industry. This has also

been supported by governmental actors, i.e. in *the Dream Commitment*, and in sectorial strategies fronting the marine sector as an already world leading actor.

In Sweden, visions have been led by several partnership-based initiatives involving public agencies, companies and research and education. In these initiatives, the forest industry has been bolstered by its historically strong position within the Swedish economy and historical linkages to research organisations, and serves as a foundation for the development of bioeconomy concepts. Many strong companies in the pulp and paper industry have been under a strong pressure for a need of change. The Swedish Forest Industry Federation has highlighted the need for seeing packaging in a lifecycle analysis of the product, as packaging contributes to reduce food waste along the value chain. Moreover, many Swedish companies are developing new techniques for utilising new products from the forest industry, and in partnership-based research initiatives, e.g. in improved viscose fabricate in collaboration with the textile industry and green chemicals and lignin in collaboration with the automobile industries.

The Scandinavian countries also differ in the industries dominating in the visions. In Denmark, the largest companies with links to the bioeconomy are Novo Nordisk (pharmaceuticals) and Carlsberg (brewing), both with ties to the agricultural production through pork and grain production, respectively. The largest bio-based firms in Norway are in the marine sector followed by the forestry sector, and bioeconomy visions support these industries. In Sweden, the largest bio-based firm, Svenska Cellulosa is in the forestry sector. The visions reflect the interests of these various actors.

In the view of the broader knowledge of systems of innovation, this is not a surprisingly finding. Yet, our findings also showed the collective character of the guiding visions. The visions for a circular bioeconomy in Scandinavia seem to result out of collectives, of the recognition of shared interest and in a co-evolution over time, resulting out of their corresponding individual interest. Regarded from the view of social movements on industry emergence, these visions result out of the recognition of shared interests, in overlapping and common beliefs. The actors start interacting in their corresponding interests, in the various actor interests and their forging of partnerships in networks. However, rival constellations appear along similar lines, and existing structures are hard to unravel. Such conflicts among the various actors also drive the process of change. Through their political behaviour, they facilitate and constrain their own interests. Our findings also showed the critical role of the national governmental strategies in the guiding visions. As social democracies, the

Scandinavian countries depend on democratic support for policy objectives, and thus visioning occurs in conjunction to grassroots predilections.

Conclusion

This paper aims at contributing to the understanding of the nature of grand societal challenges and the challenge-driven research and innovation policy, by studying the guiding visions for a circular bioeconomy in Scandinavia. We have looked into the boundary object of the notion of a circular bioeconomy, as an entity interpreted in different ways with different communities, to unpack processes of deliberation and contestation among sets of heterogeneous actors that underpin the future visions for a circular bioeconomy. According to the field of sustainable transition research, shared future visions are considered essential for providing directionality in governance approaches to challenge-driven research and innovation (Loorbach 2010; Raven 2010; Weber and Rohracher 2012).

From an empirical grounded mapping, our findings showed that the guiding visions for a circular bioeconomy in Scandinavia is strongly coloured by the central actors involved in the process. In Denmark, central companies in new emerging industries have been the most influential actors. In Norway, the governmental initiatives of a national bioeconomy strategy has laid the ground. In Sweden, visions have been driven by partnership- based initiatives. These findings show that the guiding visions result out of the different institutional set up in these three Scandinavian countries.

From this, these findings also illustrate the enduring challenges for grassroots movements when creating visions for institutionalised change, as pointed at by Smith and colleagues (Smith et al. 2012). Applied to the circular bioeconomy, our findings show several enduring challenges of creating a viable bioeconomy vision through grassroots actions, at the geographical scale, the temporal scale, and the thematic structure of the vision. Our findings illustrate in many ways these enduring challenges, e.g. in the state of the visions, the complexity of the problem character it sorts to address, the various and conflicting interests of the actors involved, and their various activities to influence on the vision. Still, the mapped visions may provide information on the challenges, in the strong actors, and the actor constellations, and correspondingly – the lack of strong actors and forging networks.

Yet, these findings may also be regarded as opportunities for the industry emergence of a circular bioeconomy. Besides, our findings also show examples of guiding visions which seems to overcoming these institutional barriers, e.g. in the partnership-based initiatives in Sweden, which have succeeded in bringing actors together across geographical and sectoral interest over an extended time. Still, most of our cases, seems to suffer from the partial engagement regarding the grand challenges targeted. Their engagements are only partial in time and scope, limited by their partial worldviews as ministries, companies, and stakeholders. The grand challenge remains unsolved. On the other hand, the notion of a circular bioeconomy is still new, and our findings may simply show the institutional barriers at an early phase for a new emerging industry. Moreover, our findings from the empirical mapping may contribute to overcome the challenges, by building further strategies on the findings of the strong and weak actor interests, networks, and collective action.

Notwithstanding, in applying theory on social movements and sustainable transition, we have aimed at addressing the need for further studying and understanding the fundamental role of visions in the challenge-driven research and innovation policy. In order to understand the nature of the enduring challenges and how these may overcome by actor interests, forging of networks, and collective action, our findings call at the need for studying ongoing social processes in emerging industries. It shows a need for mapping empirically such social processes to get an overview of the partisan actors and their networks, to create understanding in the potential for how these could be strengthened. Furthermore, it shows the need for empirical studies going into depth in emerging phenomenon of innovation, in understanding the critical mechanisms creating processes of change, in the complex setting of technical, societal and institutional processes in grand societal challenges.

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